Thinking Machines Corporation

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CORPORATE BACKGROUND

Thinking Machines Corporation was founded in May 1983 based on an understanding of how two evolving technologies -- parallel processing and artificial intelligence -- would combine to create a computer with fundamentally new and different capabilities.

The company's founders saw that the technologies for understanding information were running far behind the technologies for creating, storing, and transmitting it. They were not alone in recognizing this information overload crisis. As they were starting, the Japanese government was initiating its Fifth Generation computer project to exploit the same technologies -- artificial intelligence and parallel processing -- in a drive for world-wide industry leadership. European countries were beginning the Esprit and Alvey projects along similar lines. In America, the federal government, realizing that these developments had important strategic implications for the balance of world power, launched a major program within the Defense Advanced Research Project Agency (DARPA).

Thinking Machines held three key advantages in this competition for the next generation of computing capability. First, the founders had a clear idea of the functions required of

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a true breakthrough computer. Second, they had access to the very best artificial intelligence technology. And, third, they had a clear belief that a small organization would yield faster and more useful results than the large development efforts under way in other parts of the world.

At the outset, Thinking Machines President and principal founder, Sheryl Handler, began assembling an exceptional team of artificial intelligence experts, computer scientists, and senior managers in a unique, interdisciplinary approach to the field. These included W. Daniel Hillis, Founding Scientist and acknowledged leader in massively parallel system design; Marvin Minsky, Founding Scientist, co-founder of the Massachusetts Institute of Technology Artificial Intelligence Laboratory, and internationally recognized authority on artificial intelligence research and applications; Richard J. Clayton, Vice President for Product Development, former Vice President for Computer Systems Development at Digital Equipment Corporation; Marvin Denicoff, Chief of Project Development and former architect of the U.S. government's programs in artificial intelligence and related research; and Mirza Mehdi, Vice President for Corporate Development, whose experience combines finance and strategic planning at large multi-national and emerging high technology companies. Early investors included William S. Paley, Frank Stanton, and Benno Schmidt.

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Additionally, Handler formed a distinguished group of "corporate fellows" -- world leaders in artificial intelligence, physics, mathematics and computer science -- to participate in the company's pioneering research. The first two fellows were Nobel Laureate Richard Feynman, professor of theoretical physics at the California Institute of Technology; and Jerome Wiesner, President Emeritus and Institute Professor at MIT.

During subsequent months, the company applied these multiple disciplines to the development of hardware and software advances that would amount to nothing less than a new generation of computing. Because of the global importance of the project, Thinking Machines continued to attract some of the world's leading computer scientists, including David Waltz from the University of Illinois, Rolf D. Fiebrich from International Business Machines Corp., and Guy Steele from Carnegie-Mellon University. As well, it built the financial, manufacturing, and marketing resources needed to bring this technology to commercial application.

In November 1985, following two years of research and development, Thinking Machines delivered its first computer system, the Connection Machine[R] computer, to the Defense Advanced Research Project Agency (DARPA), which traditionally has funded some of the most significant developments in computer technology.

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Subsequently, on April 30, 1986, the company introduced the first commercial version of the Connection Machine system, a massively parallel computer that can process extremely large volumes of data at speeds exceeding one billion instructions per second (1,000 MIPS).

"The demand for a computer with fundamentally new capabilities has never been in question," says Handler. "We were determined to be the first to supply it."

Such computational power is possible because of the Connection Machine system's unique parallel architecture, which differs substantially from other computer systems. While some machines speed a problem's time to solution by linking a small number of processors in parallel -- from a half dozen to several hundred -- the Connection Machine system's massively parallel design employs up to 64,000 individual processors, each with its own memory, that compute simultaneously. Unlike other parallel computers, whose processors are pre-wired to communicate in a specific pattern, the Connection Machine processors are automatically linked by the machine to match the structure of each problem as it is being solved.

The Connection Machine System

Thinking Machines recognized from the outset that business and government needed a computer able to handle data at a rate considered impossible using conventional technology. The

system had to understand huge amounts of unstructured data, not just create more of it. It had to compute directly at the level of the data itself.

These requirements pointed the way to a radical new architecture, with a very large number of processors embedded directly in the memory, where the data resides. This architecture addresses the inherent parallelism that exists at the data level of many important problems. At the data level it is common to do thousands of operations in parallel. Conventional multiprocessor computers rarely achieve speedups of more than ten, and even these incremental advances require more complex programming techniques.

The crucial design challenge for Thinking Machines lay in the way these processors were interconnected. The company's scientists, led by Hillis, had to make the connections fast, but they also had to make them flexible. Systems with a rigid network of connections limit themselves to a small set of applications. However, a system that allows free and easy connections among tens of thousands of processors can provide exactly the kind of computing power the world needs as it moves into the "information economy" of the 21st century.

The Connection Machine system is the dramatic result of this design effort. Its 64,000 processors operate at sustained speeds above 1,000 MIPS. (In contrast, large conventional mainframes operate at less than 40 MIPS.) The Connection Machine processors

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are linked by a communications system that exchanges data at speeds above 3 billion bits per second, a rate equivalent to 1,000 conventional computer networks. Linkages between processors are totally dynamic; they change to match the changing nature of applications programs.

For users, the result is a computer that looks at the whole problem at once. Its 64,000 processors search whole databases, process whole pictorial images, and simulate whole VLSI circuits simultaneously. It is a much simpler approach that is also a much higher performance approach. The parallelism inherent in data structures grows with the size of the data. Processing all the picture elements in an image, for example, is as fast as processing one of them. A whole database can be searched in the time it takes to search one document.

The Market

Initial Connection Machine applications have provided proof that the design is right. In word and language applications the system is allowing certain artificial intelligence algorithms to be applied to real world problems for the first time. Among these algorithms is a method for searching huge unstructured databases through whole document comparison. In picture and vision applications, the system is allowing image comparison algorithms to operate in seconds instead of minutes or hours.

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One example is the computing of contour maps from aerial photographs taken from slightly different angles.

Numeric and scientific applications are providing some of the earliest uses for the Connection Machine system. To remain true to the physical reality, mathematical models must often be "non-uniform," more dense in one place, less dense in another. Conventional vector computers force a uniform structure onto these models. The Connection Machine system adapts directly to the natural structure of the problem. Fluid dynamics simulation and linear programming are just two examples of scientific and numeric applications of the Connection Machine system.

The company has focused its initial product on large-scale users in industry, universities, and government agencies. These customers have already invested in large-scale computing resources, but even the largest conventional machines are inadequate for their needs. They are looking to a new technology to break their information understanding bottleneck. For example, because the Connection Machine system is well suited to reducing the time to search large quantities of unstructured text, information services organizations are prime potential customers.

The Future

How will Thinking Machines maintain its lead? Handler points to the company's inherent strengths: "Thinking Machines

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is a combination of compelling vision and excruciatingly high standards for execution. It is my job to make progress without compromising either."

She describes the company's approach: "We seek a blend of the finest minds. We create fire by rubbing them together in an environment of sharp focus and superb tools. It gets results."

The company sees the Connection Machine system as the building block of a major new industry. "The architecture is applicable to a wide range of problems, and it's extremely cost-effective," notes Clayton, who is responsible for Connection Machine business operations. "We are growing to meet demand."

Much of the growth is expected to come from new applications. The company sees its architecture as an enabling technology for information understanding. Systems that understand unstructured information will be possible for the first time, thereby opening up new markets.

Perhaps most important, the company sees the Connection Machine system as a key milestone on the road to a true thinking machine. "Every time we move a step closer to that goal," notes Hillis, "we gain power to understand the flood of information around us. This fills a real need, and filling a real need is what makes a company successful."

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Connection Machine[R] is a registered trademark of Thinking Machines Corp.

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